THE WEATHER AND CIRCULATION OF JANUARY 1954 [1]

A Low Index Month With a Pronounced Blocking Wave

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MONTHLY MEAN CIRCULATION

During January 1954 the monthly mean zonal index (35° N.–55° N.) at 700 mb. for the Western Hemisphere averaged below its normal value for the first time since April 1953 [1]. This is indicated in figure 1, which shows the observed and normal monthly zonal indices for the past 10 months. The index reached its highest monthly average and also its greatest positive deviation from normal in the period from mid-November to mid-December 1953, and thereafter experienced a steady decline to speeds that were weaker than normal. Five-day mean values for December and January show that the index dropped from 13.7 m/sec late in December to a minimum of 8.4 m/sec early in January, followed by a recovery to a value (11.1 m/sec) near the normal later in the month. As can be seen from figure 2 these changes were accompanied by shifts in the latitude of the maximum westerlies, southward from about 50° N. on December 27 to about 37° N. on January 8 and then northward. At the end of January the westerlies were shifting southward for the second time once more accompanied by a falling zonal index.

During the southward shift of the westerlies, sea level pressures increased at high latitudes. North of 40° the average pressure over the Western Hemisphere was well above normal for the month, as may be seen in figure 3. At lower latitudes, on the other hand, pressures averaged below normal, so that the polar anticyclones grew at the expense of the subtropical high pressure cells, a condition considered typical of low index [2].

Corresponding to the low index state, the monthly mean position of the belt of maximum westerlies at 700 mb was south of normal in the Pacific and western and central North America (fig. 4a). As a result wind speeds averaged above normal north and northwest of the Hawaiian Islands and along the Pacific coast of the United States (fig. 4b). They were also above normal along a second-

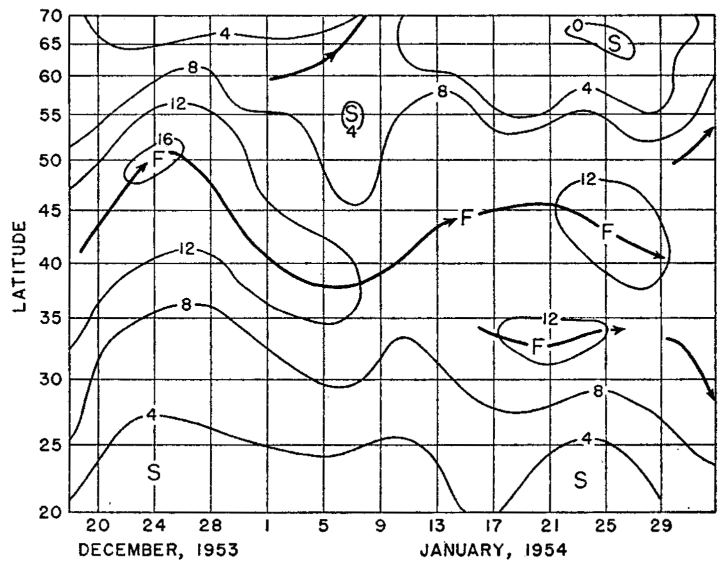

FIGURE 2.—Time-latitude section of 5-day mean 700-mb. zonal wind speed (m/sec) in the Western Hemisphere for period December 18, 1953, to February 2, 1954. Heavy arrowed lines mark latitude of axes of maximum wind speed. Notice the latitudinal variation of the maximum westerlies during late December and January.

[1] See charts I–XV following p. 41 for analyzed climatological data for the month.

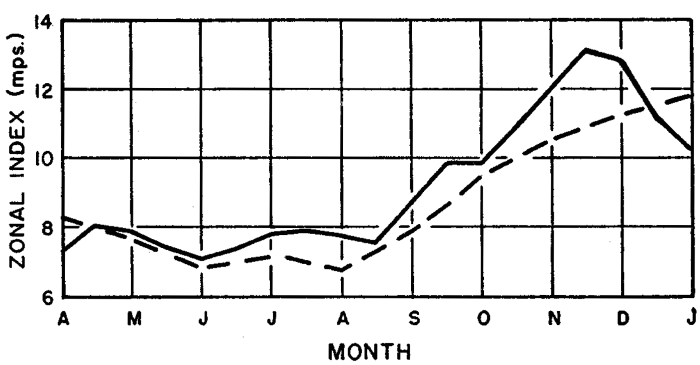

FIGURE 1.—Variations of the mean monthly zonal index at 700 mb. for the Western Hemisphere in the latitude belt 35°–55° N. from April 1953 to January 1954 with normal index dashed. Notice the 8-month period during which the index was above normal.

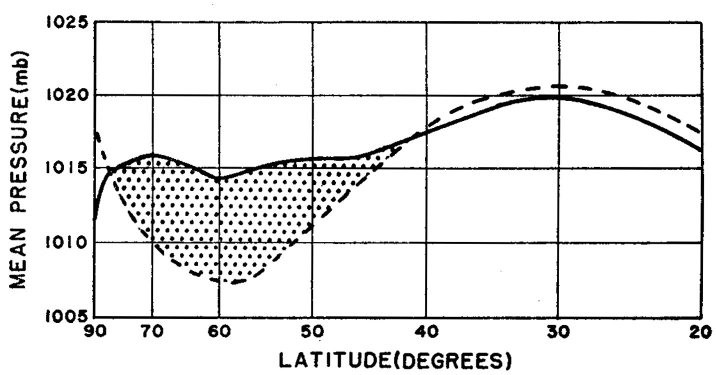

FIGURE 3.—Mean sea level pressure profile in the Western Hemisphere for January 1954 with normal profile dashed. Pressures were above normal north of 40° N. (shaded area).

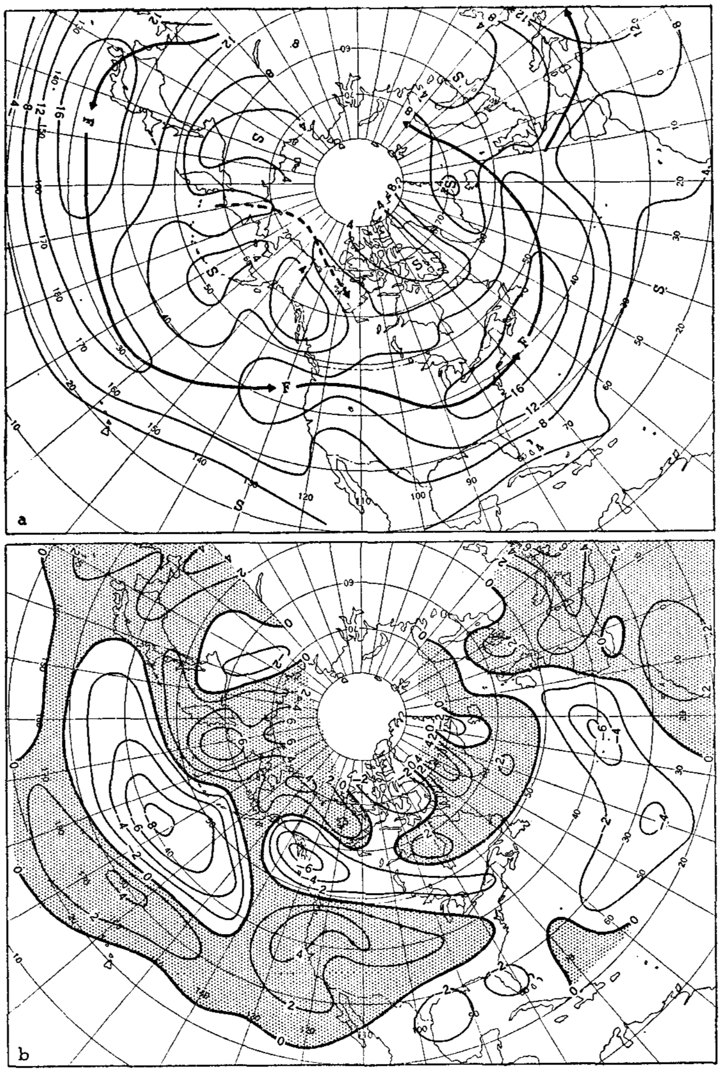

FIGURE 4.—Mean 700-mb. isotachs (a) and departure from normal wind speed (b) (both in m/sec) for January 1954. Solid arrows indicate the average position of the maximum westerlies, which were well south of normal in the Pacific. Dashed arrow from northeast Siberia to northwest Canada indicates secondary axis of westerlies around block in Bering Sea.

ary axis of maximum winds from Kamchatka to the Yukon, where the westerlies were forced to flow around a strong blocking High in the Bering Sea (figs. 4 and 5). In the central Pacific and western Canada wind speeds averaged as much as 6 to 8 m/sec below normal, as contrasted with December, when wind speeds averaged as much as 7 m/sec above normal in these same regions [3]. In the Atlantic and eastern United States the axis of the maximum westerlies was observed in its normal position and at speeds close to normal.

Blocking activity was a major factor in determining the prevailing flow pattern for January. As may be seen from figure 5, 700-mb. heights were well above normal in the northeastern Atlantic and in the Bering Sea, regions which are frequent sites for blocks [4]. In response to the strong ridge in the Bering Sea very cold air was driven southward into western Canada and the eastern Pacific, resulting in frequent cyclogenesis and subnormal heights off the coasts of Washington, Oregon, and British Columbia. An abnormally deep Low in the Sea of Okhotsk was also related to the blocking inasmuch as strong cyclones were blocked by the ridge. Across the United States flow at 700 mb. was nearly zonal despite the fact that the zonal index from 0° westward to 180° averaged below normal. These regional variations in index are frequently observed, and point up the danger of using a hemispheric index to define a regional circulation pattern.

BEHAVIOR OF THE BLOCK

A major feature of blocking as given by Namias [5] is that a regional retardation of the westerlies progresses slowly westward. This feature was conspicuous during January, as figure 6, showing time-variation of regional zonal indices, clearly indicates. An index minimum was reached about the first of January in the eastern Atlantic, the 5th in the western Atlantic, the 10th in North America, the 20th in the eastern Pacific, and finally about the 31st in eastern Asia. The average rate of westward motion of the index minimum during this period was 52° of longitude per week. This rate, however, was not uniform, varying from about 30° of longitude per week in the Pacific to 70° per week in the Atlantic and North America.

It is noteworthy that both these average and sectional rates compare closely with rates computed for a similar blocking case observed during January 1944 by Namias [5].

The changes that took place at various longitudes as blocking spread westward are shown in figures 7 and 8. Figure 7 shows the changes in 700-mb. heights computed at 60° N. from 5-day mean charts 1 week apart. Large rises originated in the eastern Atlantic about 20° W. and spread westward during the month, reaching 160° W. about January 10 and 120° E. about January 31. The long-period trends occurring at most longitudes are striking. For example, strong height rises at 160° W. (Alaska) after January 5 continued for 2 weeks, followed by falls during the remainder of the month. Of interest also is the large magnitude of the changes in the two favorite regions of blocking (160° W. and 0°). In fact most longitudes experienced their highest heights and largest variations as the wave of blocking passed.

While height rises originated in the eastern Atlantic and spread westward to the Pacific it should be emphasized that the ridge in the eastern Atlantic did not bodily retrograde to the Pacific. Instead, blocking spread by means of successive upstream intensification of ridges and weakening of troughs [5].

In figure 8 a series of 5-day mean 700-mb. height anomalies at intervals of one week have been plotted on a polar projection for the regions north of 40° N. Figure 8A shows the block in the eastern Atlantic shortly after it was established, as indicated by an anomaly of +850 ft. at 55° N., 20° W. During the next week (fig. 8B) the anomaly maximum retrograded to 30° W. with height rises

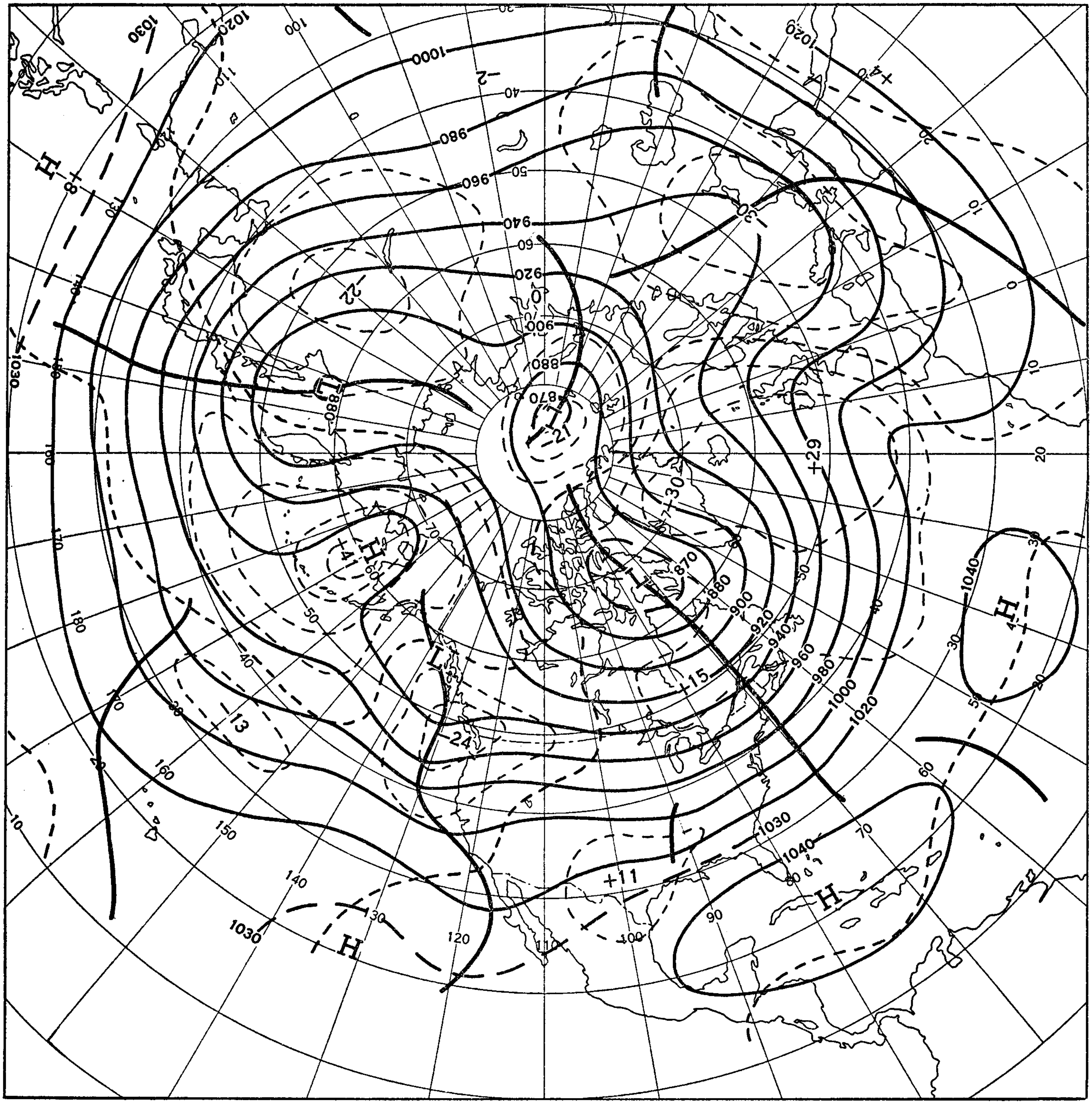

FIGURE 5.—Mean 700-mb. height contours and departure from normal (both in tens of feet) for January 1954. Above normal heights prevailed north of 50° N. in the Western Hemisphere.

spreading westward from this center, as shown by the large positive anomalies extending to about 120° W., where a week earlier heights had been below normal. The following week (fig. 8C) the block became well established over the eastern Pacific with maximum departures of +900 feet around 55° N., 165° W., while heights fell away over Canada. In the Atlantic the blocking condition almost disappeared as strong zonal flow became re-established. Figure 8D indicates a very slow retrogression of the block. To its east abnormally cold air was advected over the Gulf of Alaska accompanied by strong cyclogenesis. Meanwhile, on the other side of the hemisphere another block developed in Eurasia. During the next week (fig. 8E) the Pacific block continued

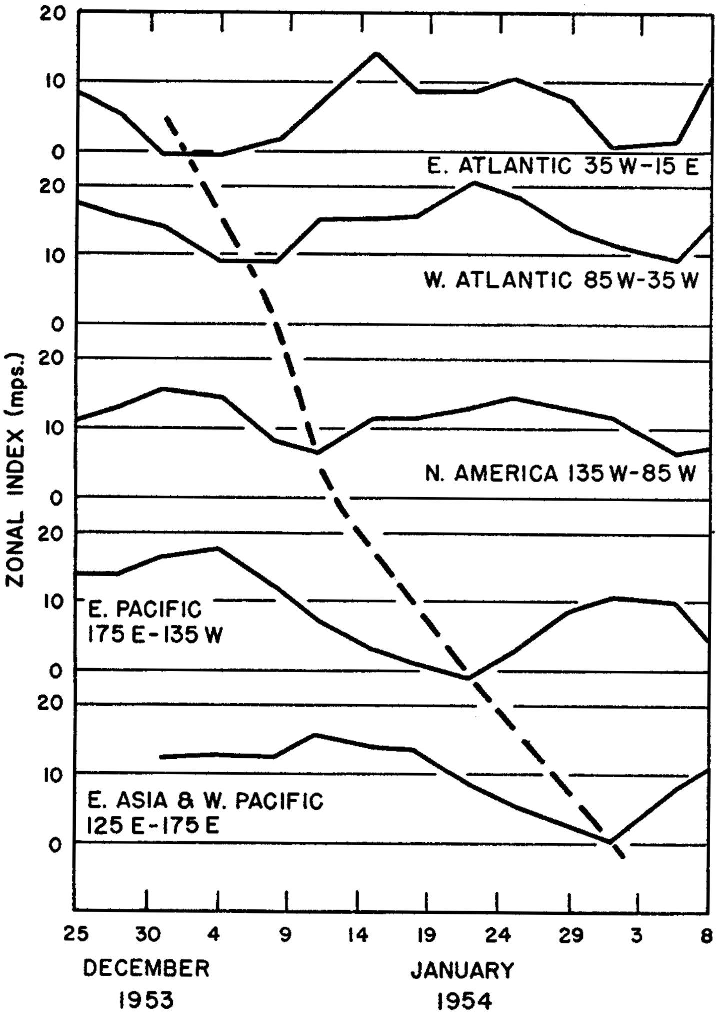

FIGURE 6.—Five-day mean values of the 700-mb. zonal index (35°–55° N.) for progressively westward sections from December 25, 1953, to February 8, 1954. The heavy dashed line indicates the minimum in successive sections. Notice how this minimum index moves westward with time.

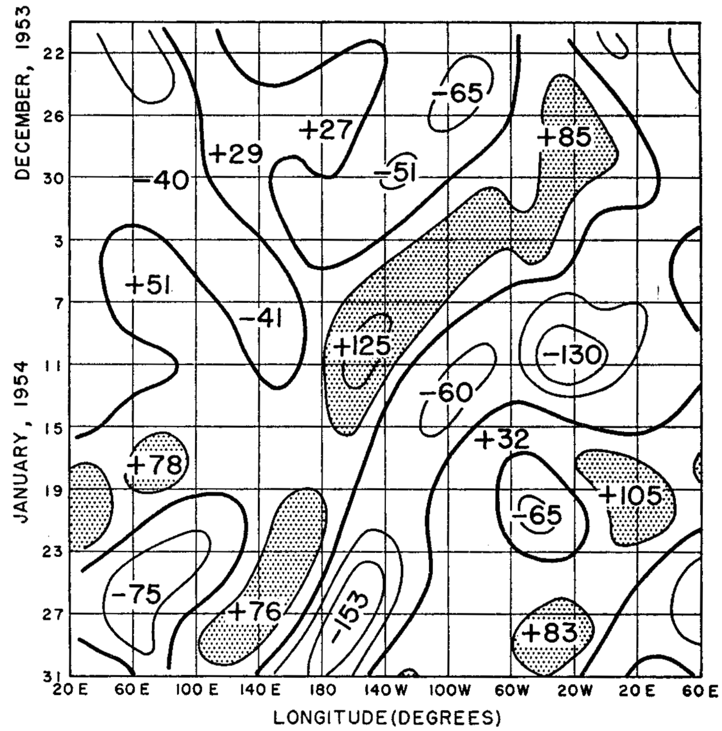

FIGURE 7.—Time-longitude section showing changes in 700-mb. heights at 60° N. (tens of feet) computed from 5-day mean charts one week apart. Isopleths drawn for intervals of 500 ft. with rises greater than +500 ft. shaded. Notice the "channel" of rises originating about 20° W. and spreading westward during January.

to retrograde slowly to near 150° E. with strong falls on its eastern side and the block in Eurasia strengthened. In the following period (not shown) the initial block fell away in Siberia.

The 5-day mean sea level maps during January (not reproduced) show that the blocking in the Atlantic resembled what Elliott and Smith [4] have referred to as low-latitude blocking, whereas the blocking in the Pacific resembled their high-latitude type. The former type "is characterized by a northward extension of the subtropical high cell where the connection with this cell is not broken; any trapped low-pressure centers being formed well to the east of the blocking high cell." On the other hand, their high-latitude type is "characterized by a high-pressure cell far to the north and trapped low-pressure areas along the southern periphery." The behavior of the blocking also seems consistent with their findings and with Yeh's theoretical results on differential rate of energy dispersion at high and low latitudes [6] since the Atlantic block, being of the low-latitude type, extended its influence westward more rapidly than the Pacific block.

THE WEATHER

Due to the small amplitude of the monthly mean flow across the United States (fig. 5) with stronger than normal westerly components over the western and central portions, mean temperatures were above normal over most of the West and South, and below normal only in the North (Chart I-B). The below normal temperatures were associated with a well developed anticyclone centered over northwestern Canada (Chart XI) and above normal sea level pressures (maximum of 8 mb.) over most of Canada (Chart XI inset). Average temperatures for the month were as low as 13° below normal in Montana and 6° below normal in New York State. It is interesting to note that this was the first time since 1948 that mean January temperatures were below normal in the Northeast. This cold air was situated for the most part to the north of the strongest westerlies where the flow was weaker than normal (fig. 4b). It appears that this cold air could not penetrate farther south in the mean due to the containing action of the fast westerlies [7].

In the Plains States the finger of below normal temperatures extending southward corresponds with the prevailing path of polar anticyclones entering the United States from Canada (Chart IX). These polar outbreaks, while frequent, were shallow and were therefore rapidly modified and swept out into the Atlantic in response to the zonal flow aloft.

In the northern Rocky Mountain States an unusually strong contrast was observed between warm Pacific air

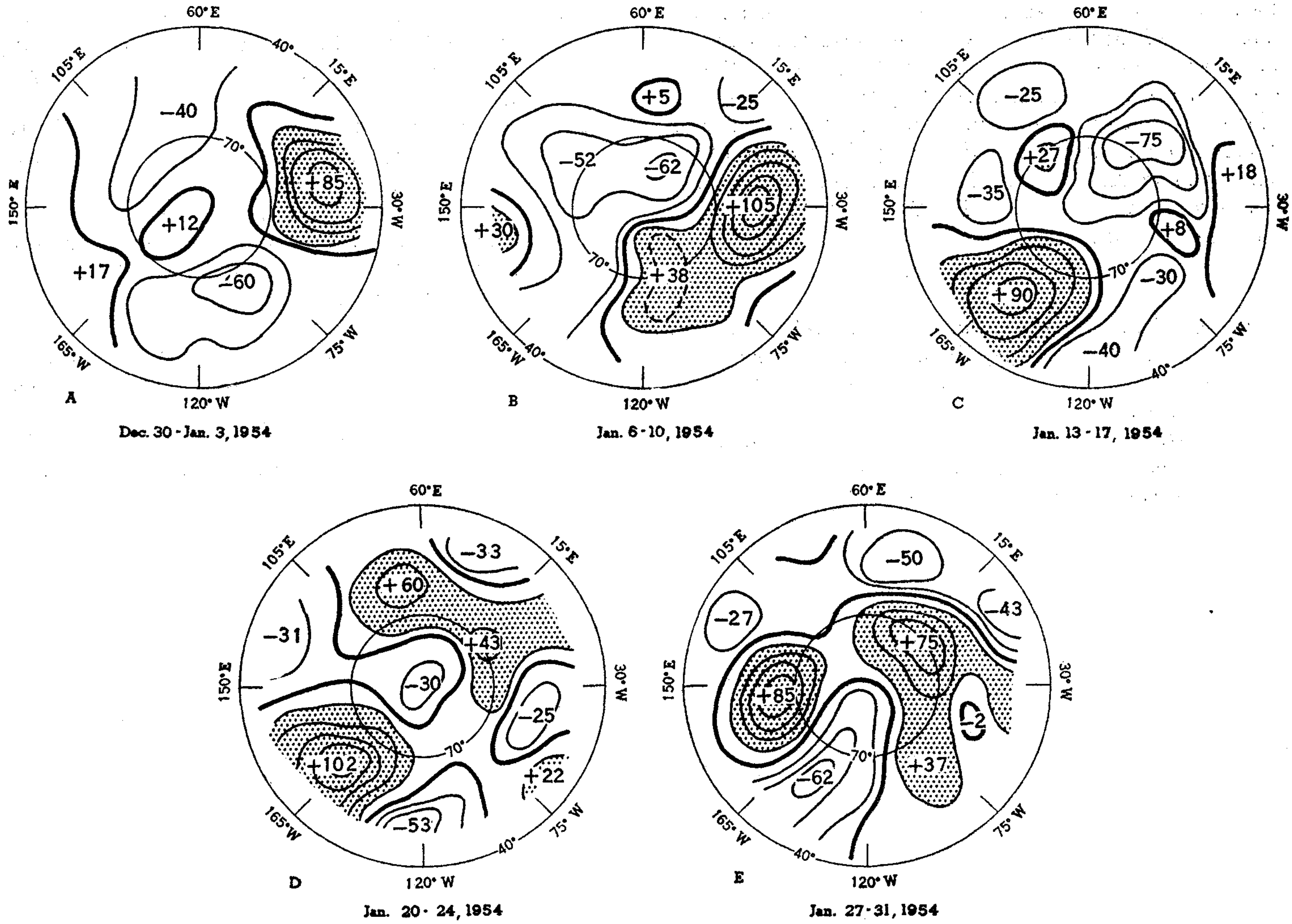

FIGURE 8.—Series of polar projections of 5-day mean 700-mb. height departures from normal (in tens of feet) north of 40° N. Isopleths are for intervals of 200 ft. with positive anomalies greater than 200 ft. shaded. Large positive anomalies appeared in the Atlantic (+850 ft.) early in January and spread rapidly westward across North America to the Pacific where the rate of westward motion diminished appreciably.

and cold Canadian air (Chart I-B). For example a surface front separating these two air masses was located between Boise, Idaho, and Havre, Mont. on 23 different days of the month. As a result Boise had a monthly mean temperature of 37° F. (10° above normal), while Havre had a monthly mean of 0° F. (13° below normal). The difference in daily mean temperatures between these stations was 40° or greater on 16 days of January and reached an extreme of 62° F. on January 23.

Precipitation amounts for the month (Chart III) exceeded normal along the west coast and in the Northern Plains, as well as in the area from Arkansas eastward to the Atlantic. Elsewhere, for the most part, amounts were below normal, with parts of the Central Plains receiving only some 10 percent of the normal. This region was located south of the principal storm track (Chart X) and was dominated by Pacific air masses which were considerably dried out upon crossing the mountains. A few cyclones went through the region, but were too weak and fast moving to be effective in producing significant amounts of precipitation.

In Tennessee and North Carolina, on the other hand, amounts as high as 200 percent of the normal were reported. This precipitation occurred primarily after cold cP outbreaks penetrated the Southern States and were overrun by warm moist Gulf air. The resulting precipitation was copious, occurring in a few storms. Knoxville, for example, received most of its precipitation in two storms which together gave 10.10 inches as compared with its total monthly precipitation of 11.73 inches.

Heavy precipitation along the Pacific Coast occurred as a result of increased cyclonic activity in the eastern Pacific and stronger than normal westerly flow over the coastal ranges. The precipitation was particularly welcome in southern California where droughty conditions had developed. Along the northern border the excess amounts occurred as a large number of cyclones traveled along the mean frontal zone.

The Atlantic block which appeared early in the month and recurred at the end of the month caused cold air from Russia and the Arctic to overspread all Europe. Frequent cyclonic activity from the Gulf of Genoa eastward to the

Black Sea was associated with low 700-mb. heights in southern and central Europe. The storminess and cold combined to give Europe some of its worst weather in years—blizzards from northern Italy to Sweden and toll-taking avalanches in the Alps. A transitory weakening of blocking activity occurred during the middle of the month and weather improved over southern Europe, only to deteriorate again at the end of the month as the second block was established.

REFERENCES

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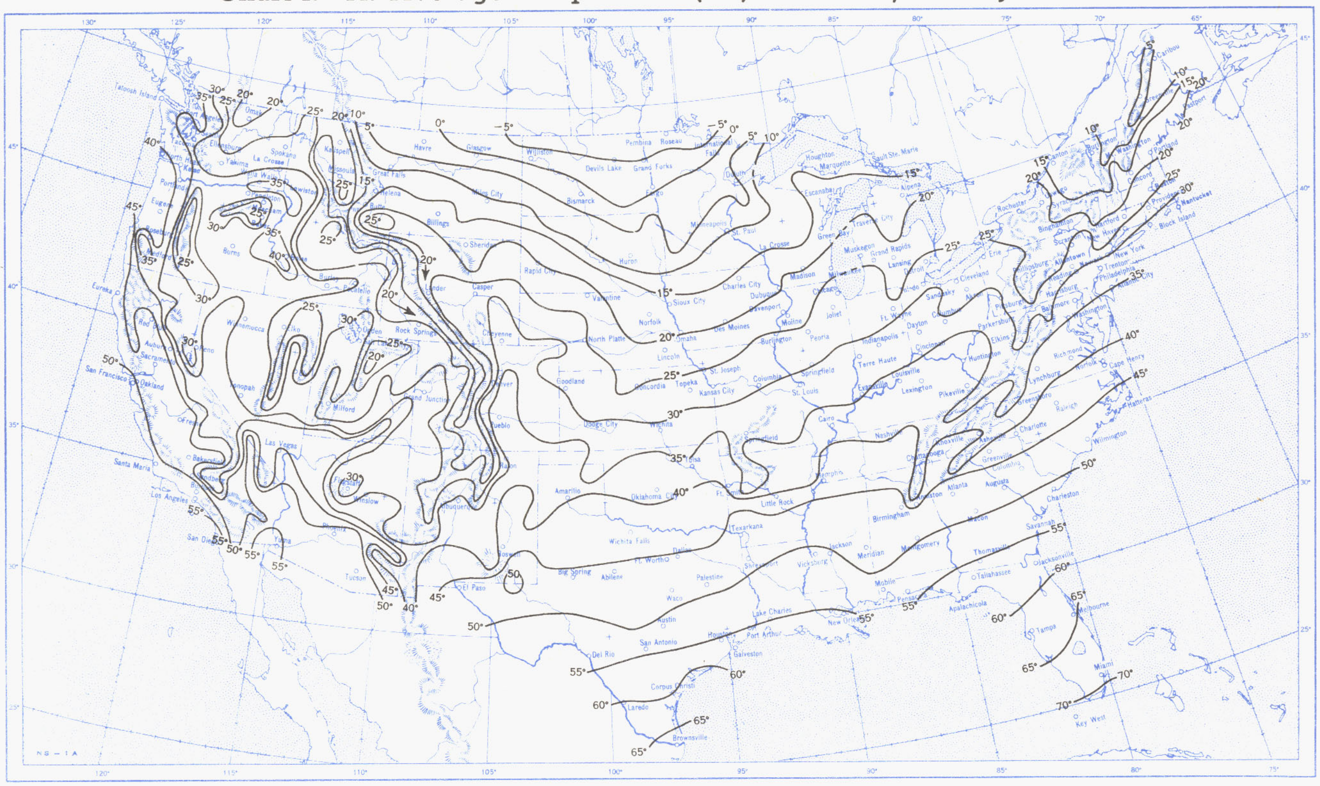
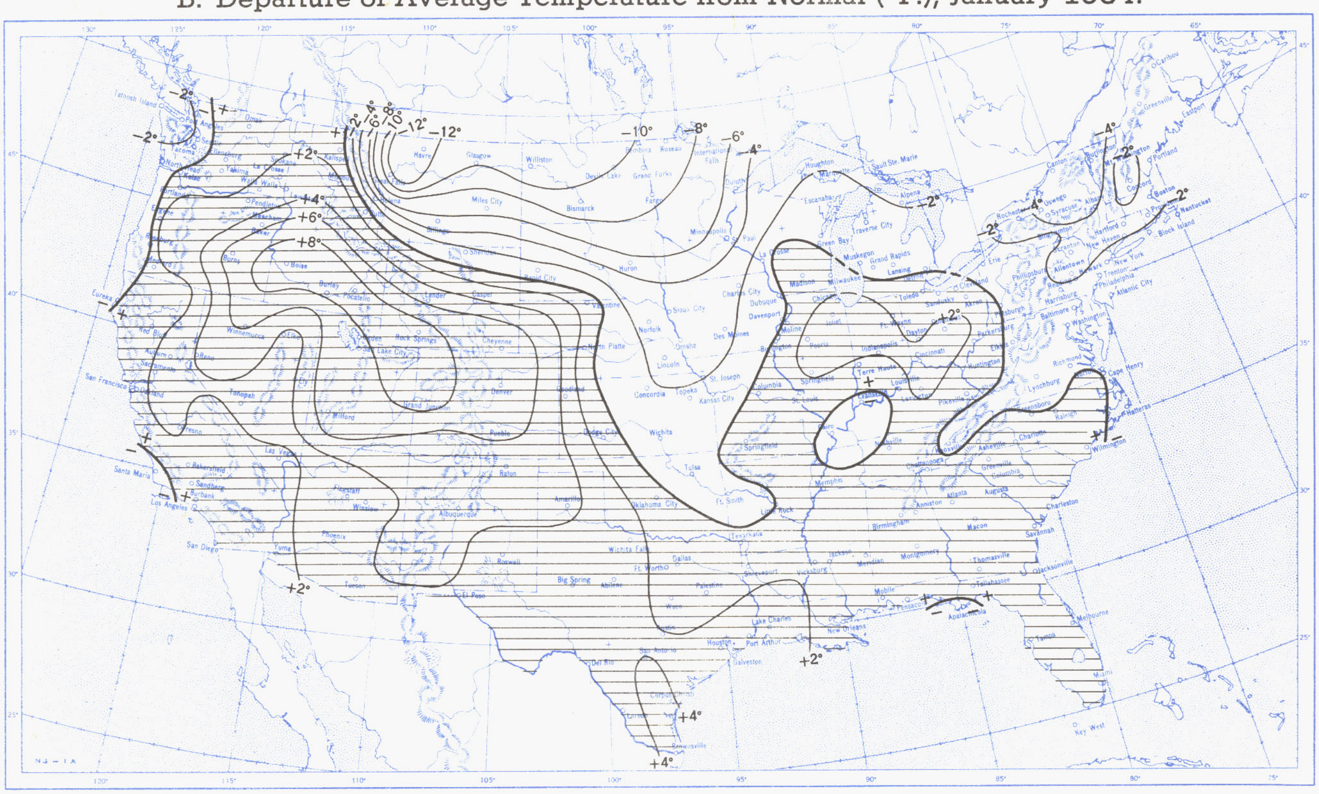
2. H. C. Willett, "Patterns of World Weather Changes", *Transactions, American Geophysical Union*, vol. 29, No. 6, Dec. 1948, pp 803–809.
3. J. S. Winston, "The Weather and Circulation of December 1953—A Month of Fast Westerly Flow", *Monthly Weather Review*, vol. 81, No. 12, Dec. 1953, pp. 392–396.
4. R. D. Elliott and T. B. Smith, "A Study of the Effects of Large Blocking Highs on the General Circulation in the Northern Hemisphere Westerlies", *Journal of Meteorology*, vol. 61, No. 2, Apr. 1949, pp. 67–85.
5. J. Namias and P. F. Clapp, "Studies of the Motion and Development of Long Waves in the Westerlies", *Journal of Meteorology*, vol. 1, Nos. 3 and 4, Dec. 1944, pp. 57–66.
6. T.-C. Yeh, "On Energy Dispersion in the Atmosphere", *Journal of Meteorology*, vol. 16, No. 1, Feb. 1949, pp. 1–16.
7. J. Namias, "The Index Cycle and Its Role in the General Circulation", *Journal of Meteorology*, vol. 7, No. 2, Apr. 1950, pp. 130–139.

Chart I. A. Average Temperature (°F.) at Surface, January 1954.

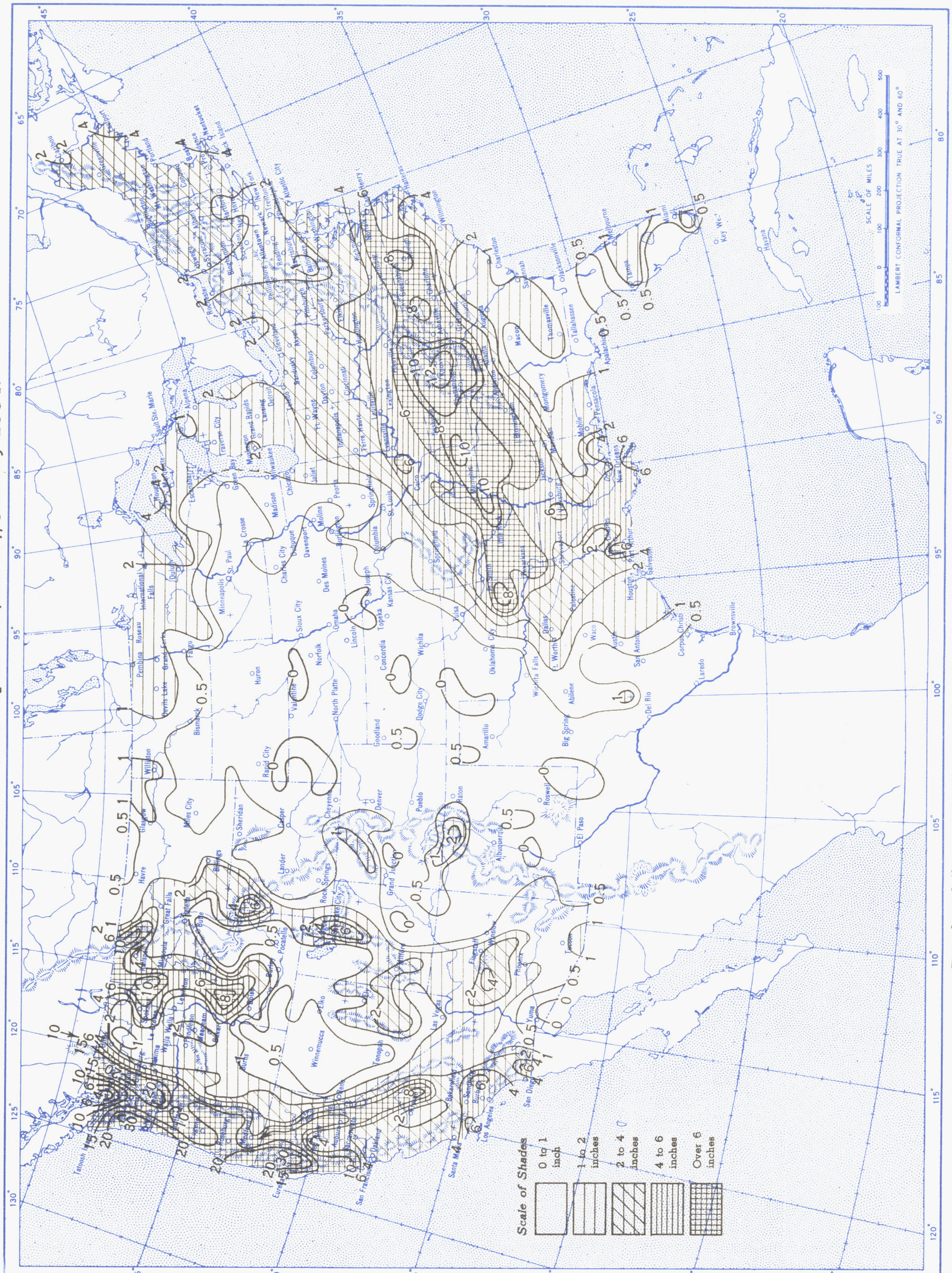


B. Departure of Average Temperature from Normal (°F.), January 1954.



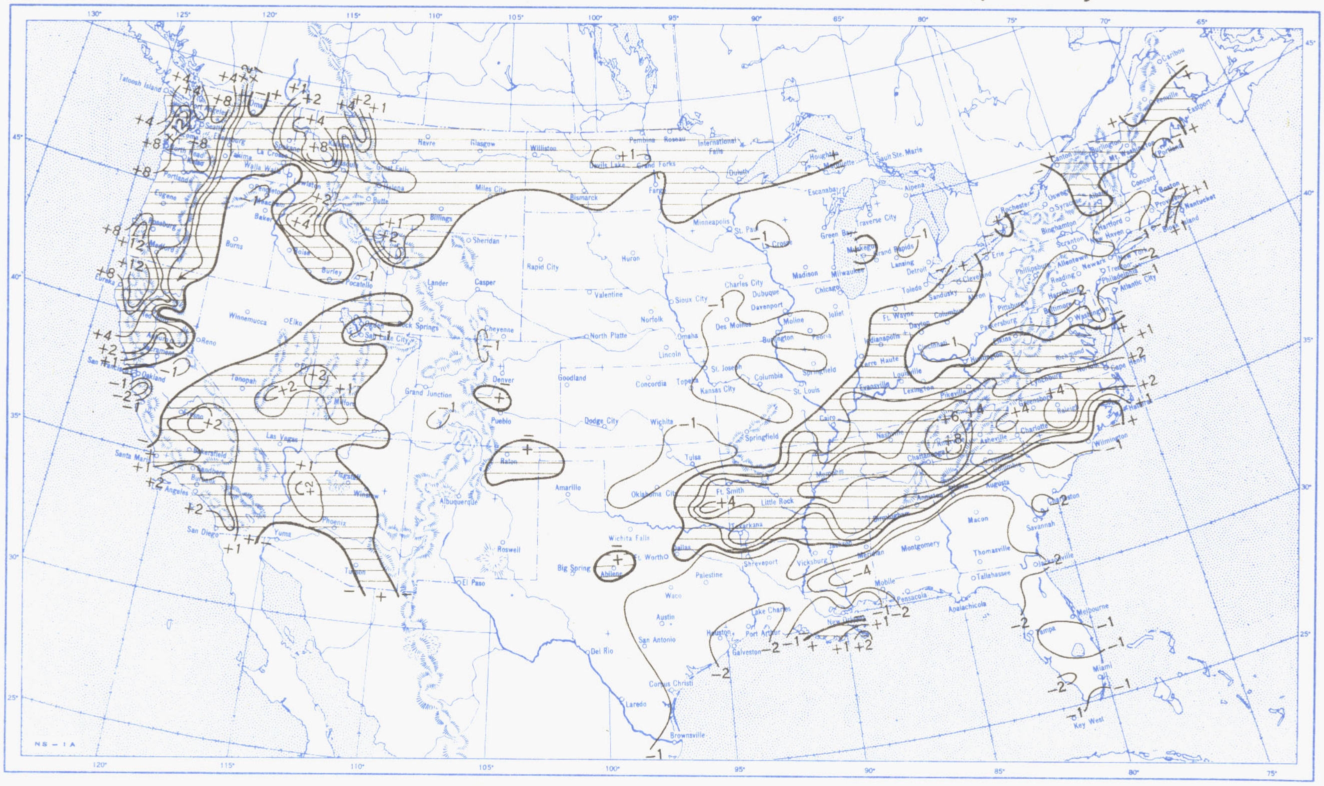
A. Based on reports from 800 Weather Bureau and cooperative stations. The monthly average is half the sum of the monthly average maximum and monthly average minimum, which are the average of the daily maxima and daily minima, respectively.
B. Normal average monthly temperatures are computed for Weather Bureau stations having at least 10 years of record.

Chart II. Total Precipitation (Inches), January 1954.

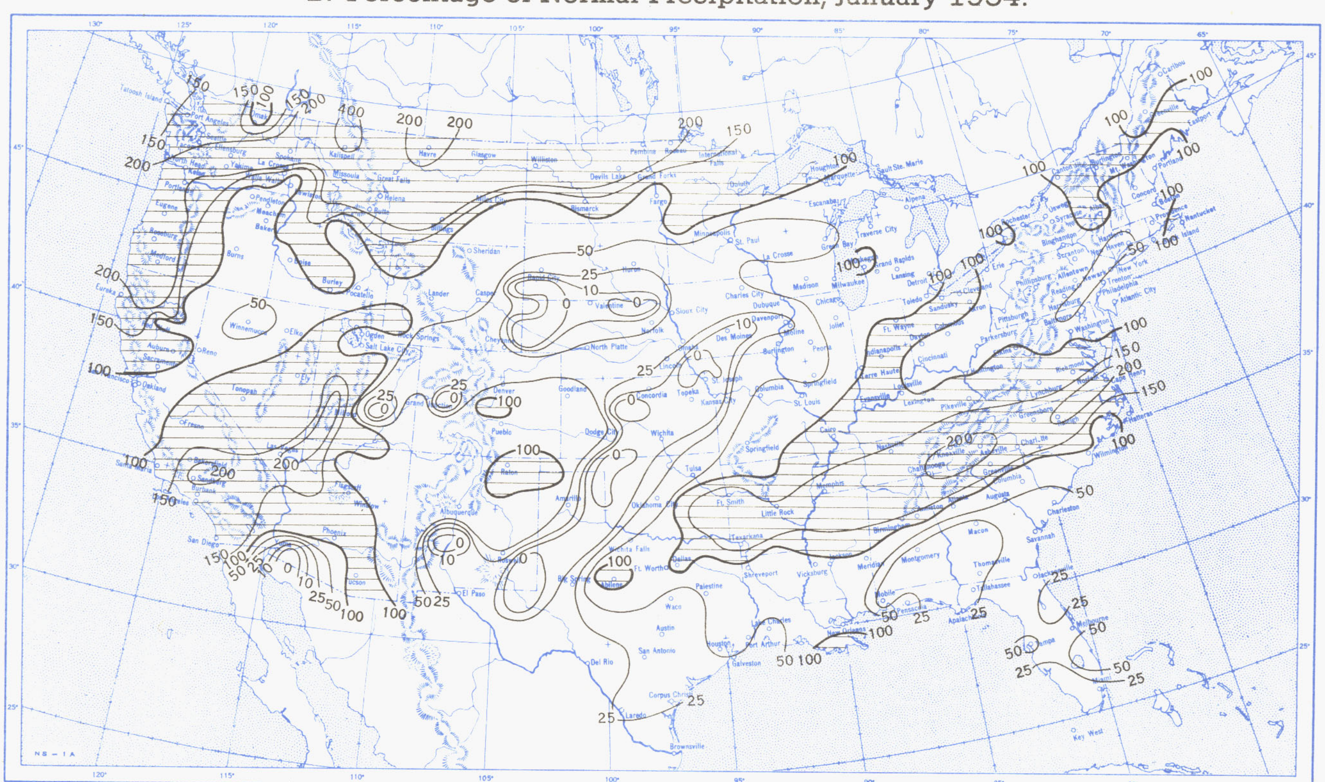


Based on daily precipitation records at 800 Weather Bureau and cooperative stations.

Chart III. A. Departure of Precipitation from Normal (Inches), January 1954.

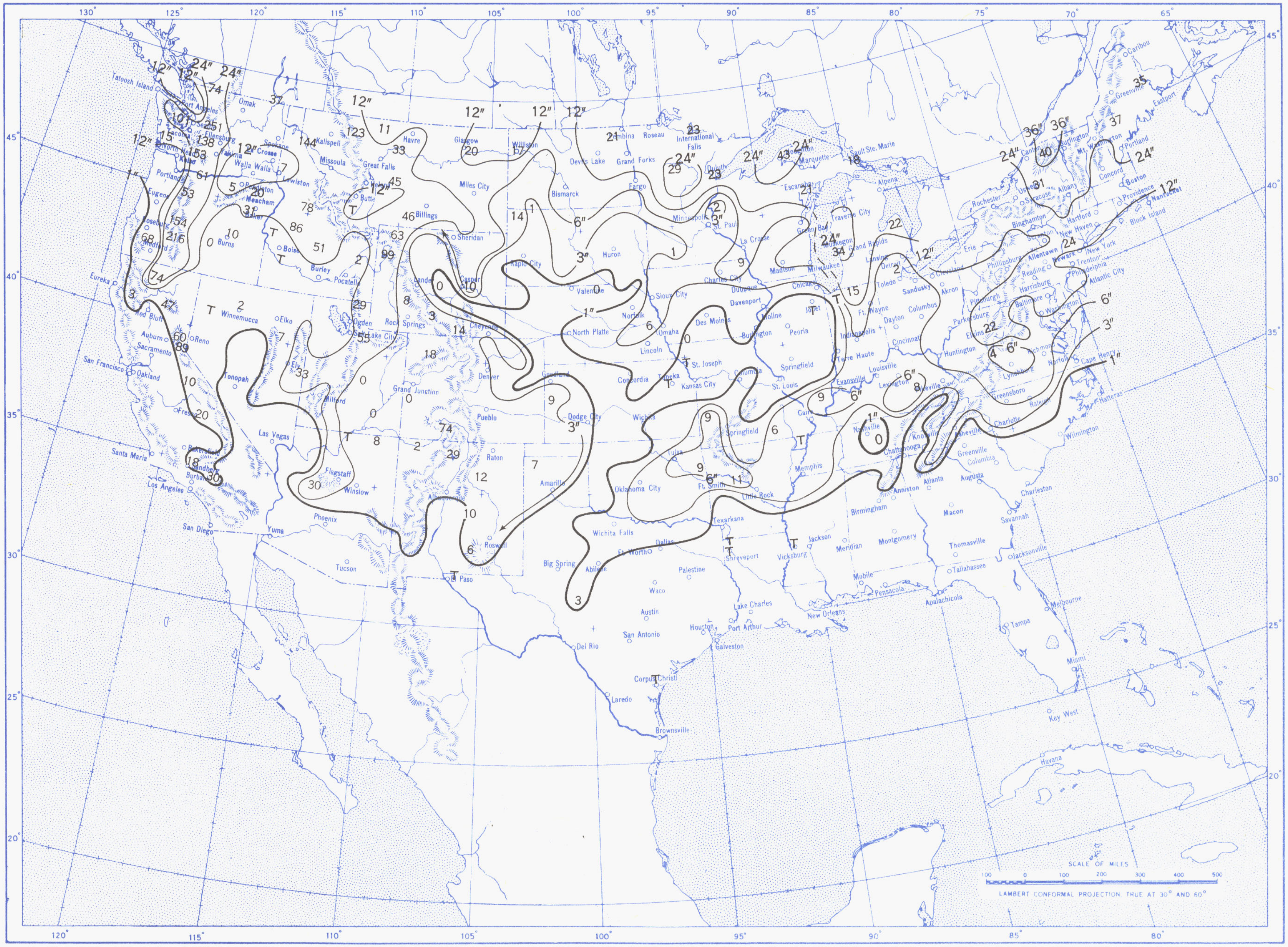


B. Percentage of Normal Precipitation, January 1954.



Normal monthly precipitation amounts are computed for stations having at least 10 years of record.

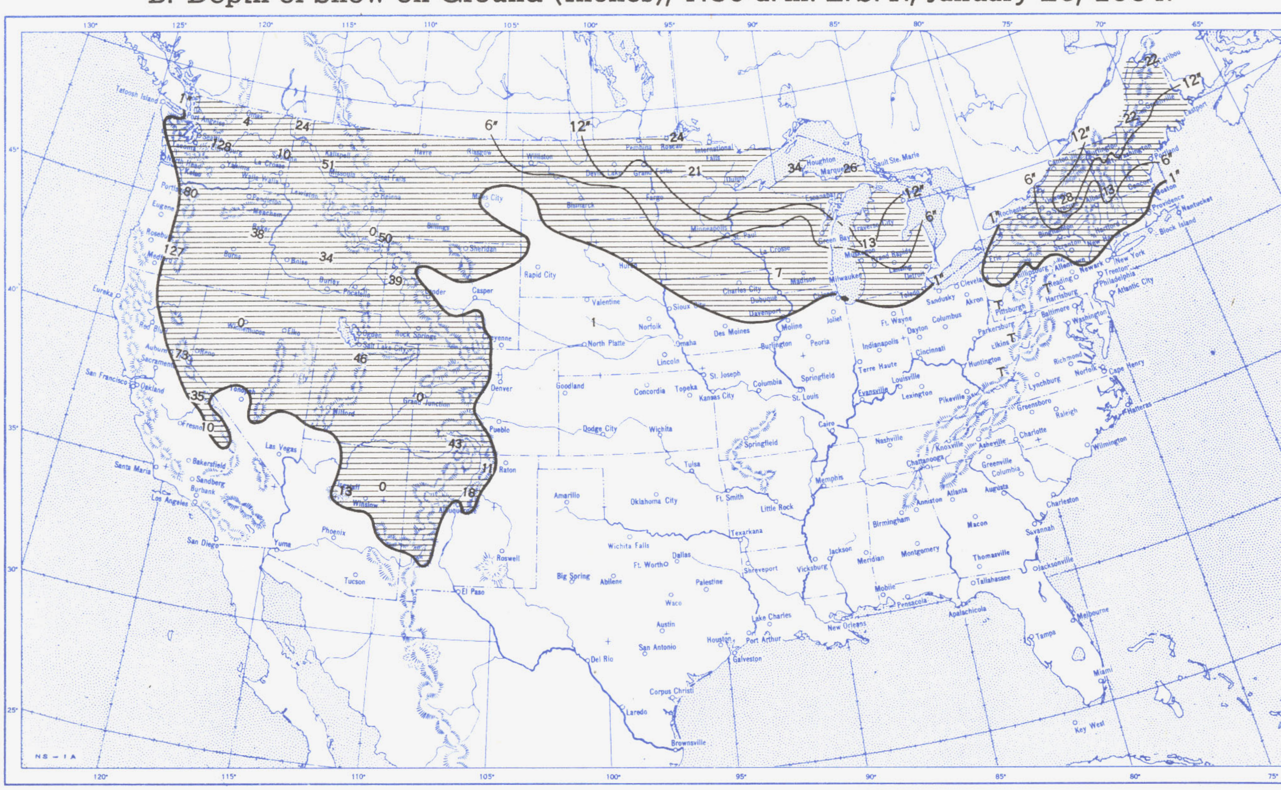
Chart IV. Total Snowfall (Inches), January 1954.



This is the total of unmelted snowfall recorded during the month at Weather Bureau and cooperative stations. This chart and Chart V are published only for the months of November through April although of course there is some snow at higher elevations, particularly in the far West, earlier and later in the year.

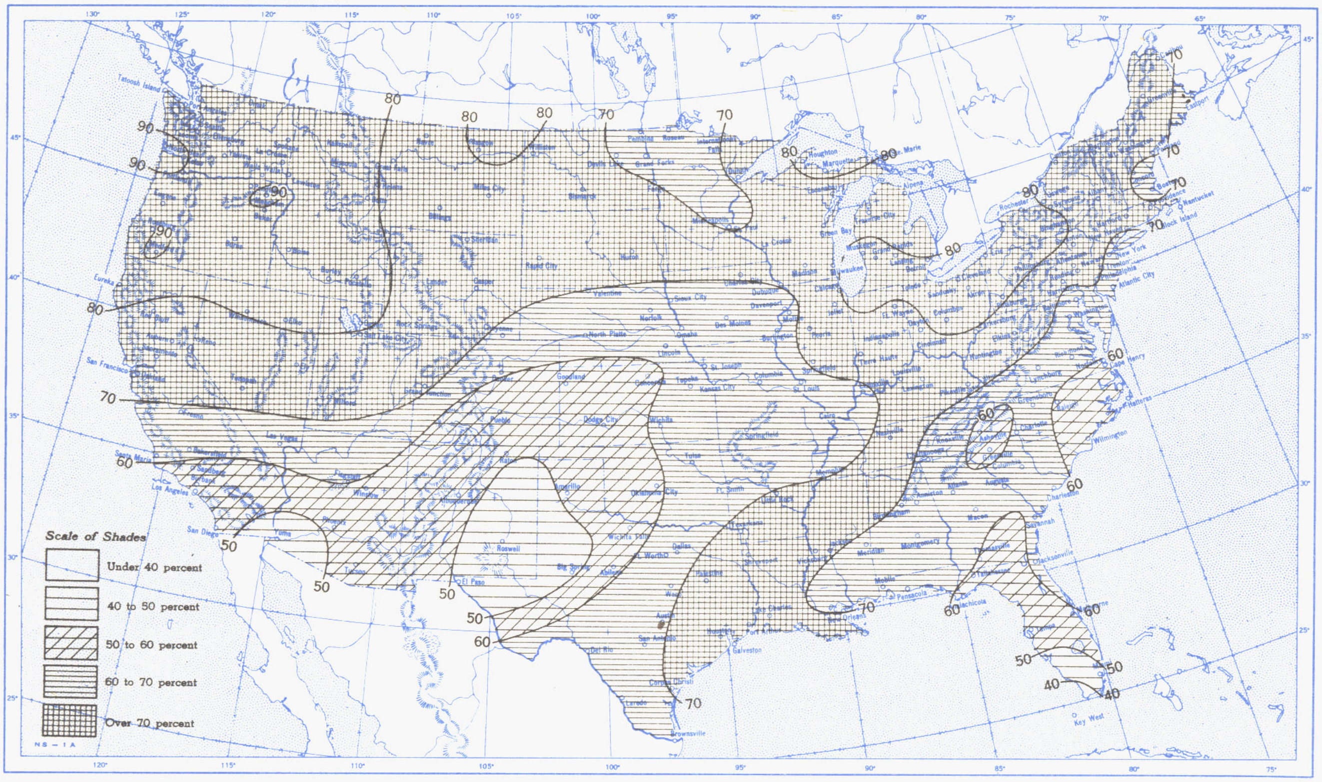
Chart V. A. Percentage of Normal Snowfall, January 1954.

B. Depth of Snow on Ground (Inches), 7:30 a. m. E. S. T., January 26, 1954.

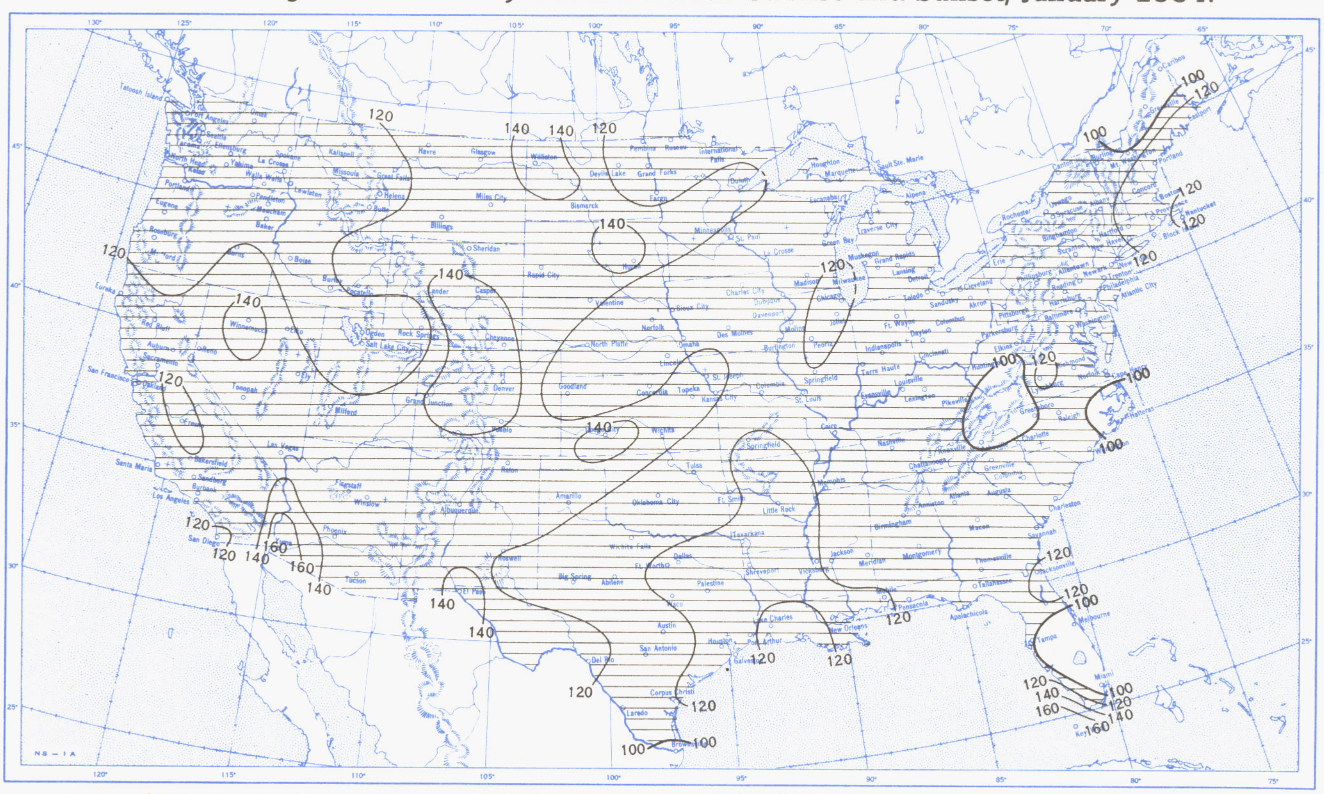


A. Amount of normal monthly snowfall is computed for Weather Bureau stations having at least 10 years of record.
B. Shows depth currently on ground at 7:30 a. m. E. S. T., of the Tuesday nearest the end of the month. It is based on reports from Weather Bureau and cooperative stations. Dashed line shows greatest southern extent of snowcover during month.

Chart VI. A. Percentage of Sky Cover Between Sunrise and Sunset, January 1954.

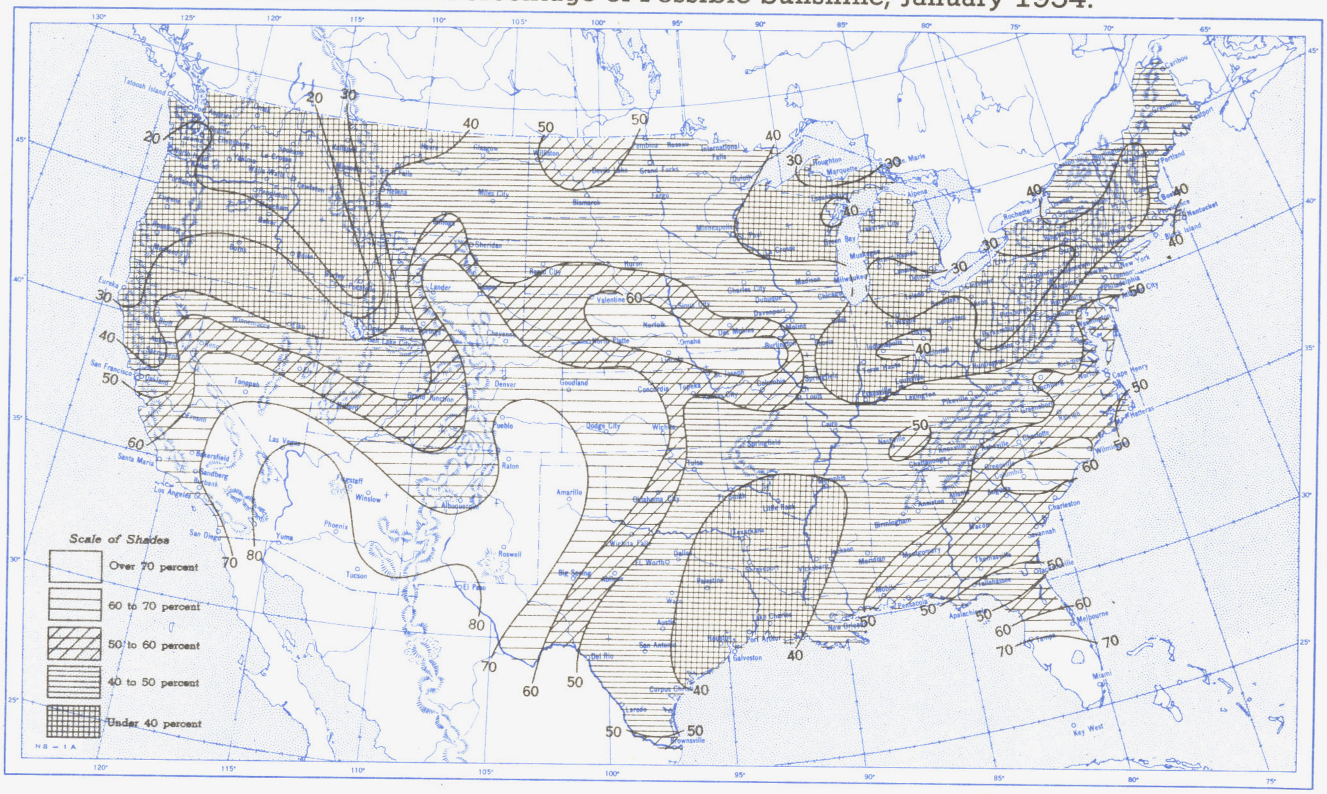


B. Percentage of Normal Sky Cover Between Sunrise and Sunset, January 1954.

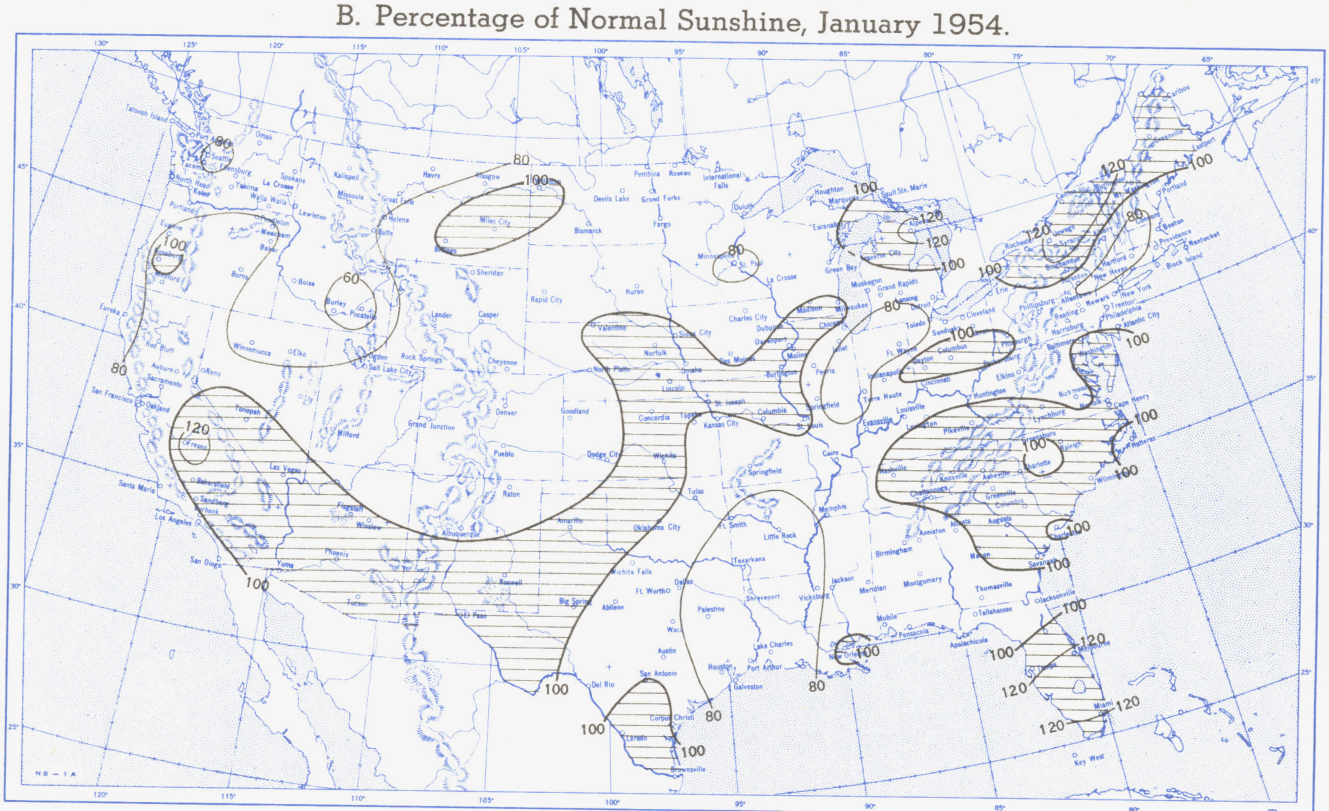


A. In addition to cloudiness, sky cover includes obscuration of the sky by fog, smoke, snow, etc. Chart based on visual observations made hourly at Weather Bureau stations and averaged over the month. B. Computations of normal amount of sky cover are made for stations having at least 10 years of record.

Chart VII. A. Percentage of Possible Sunshine, January 1954.



B. Percentage of Normal Sunshine, January 1954.



A. Computed from total number of hours of observed sunshine in relation to total number of possible hours of sunshine during month. B. Normals are computed for stations having at least 10 years of record.

Chart VIII. Average Daily Values of Solar Radiation, Direct + Diffuse, January 1954. Inset: Percentage of Normal Average Daily Solar Radiation, January 1954.

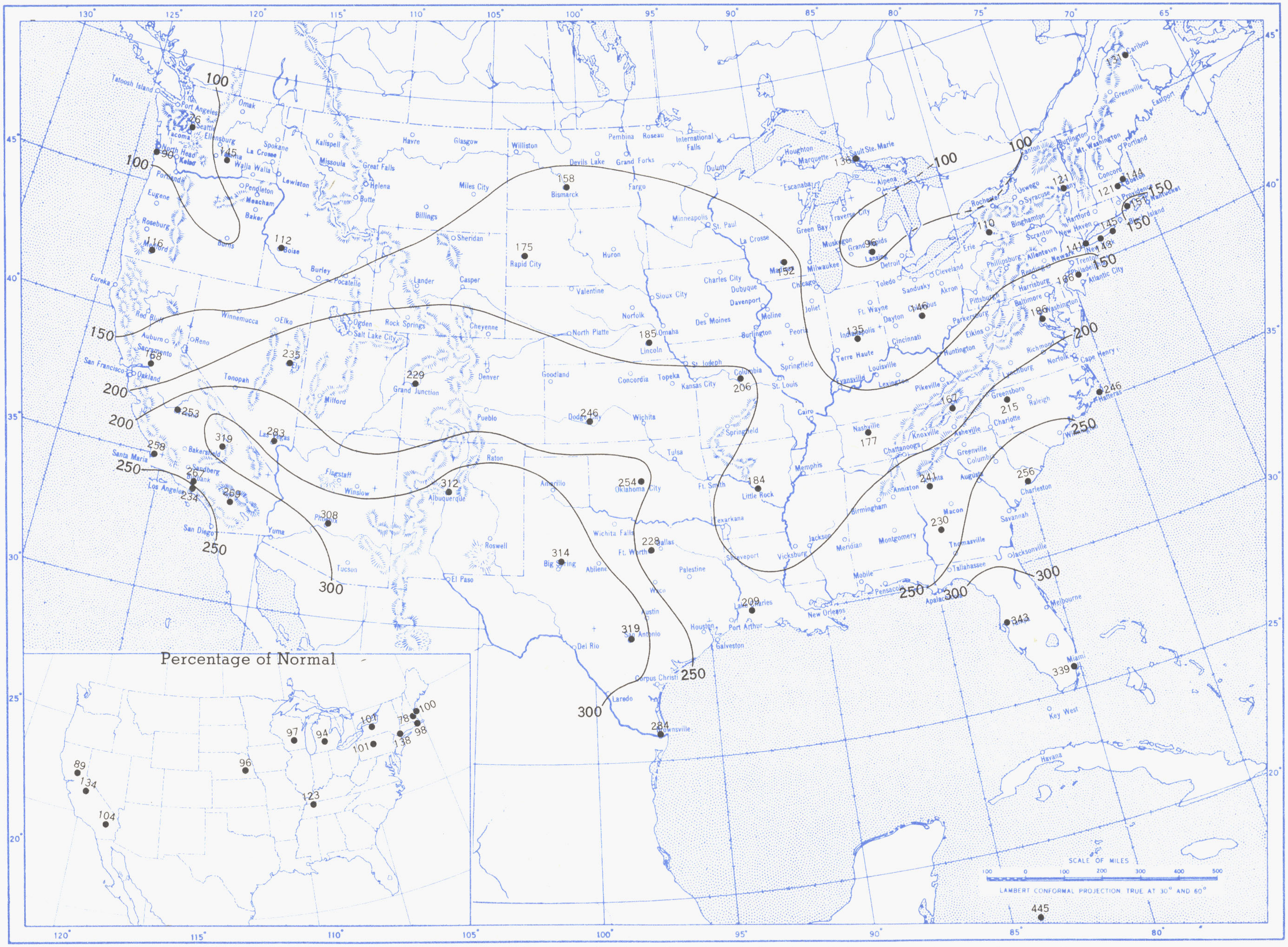
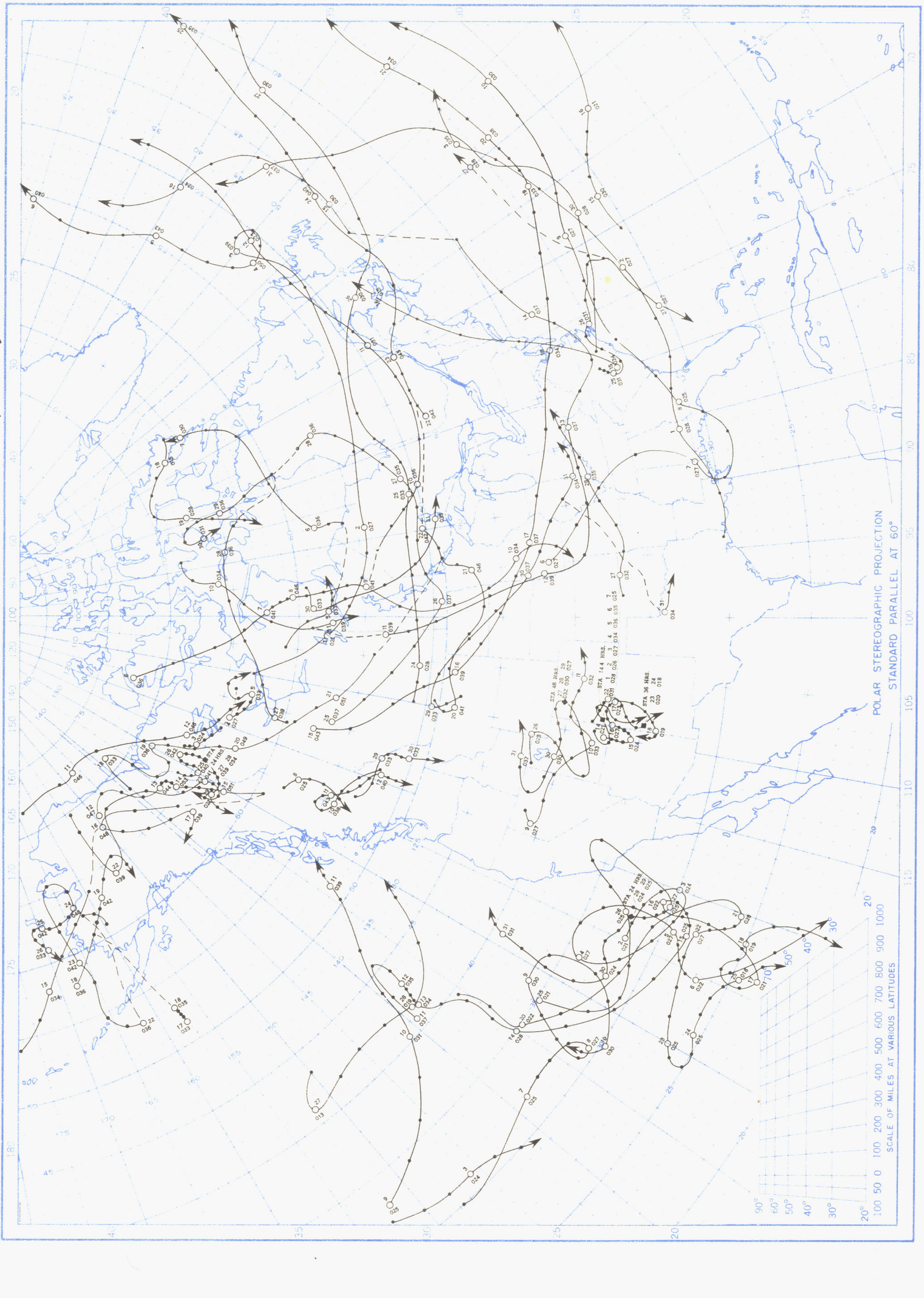


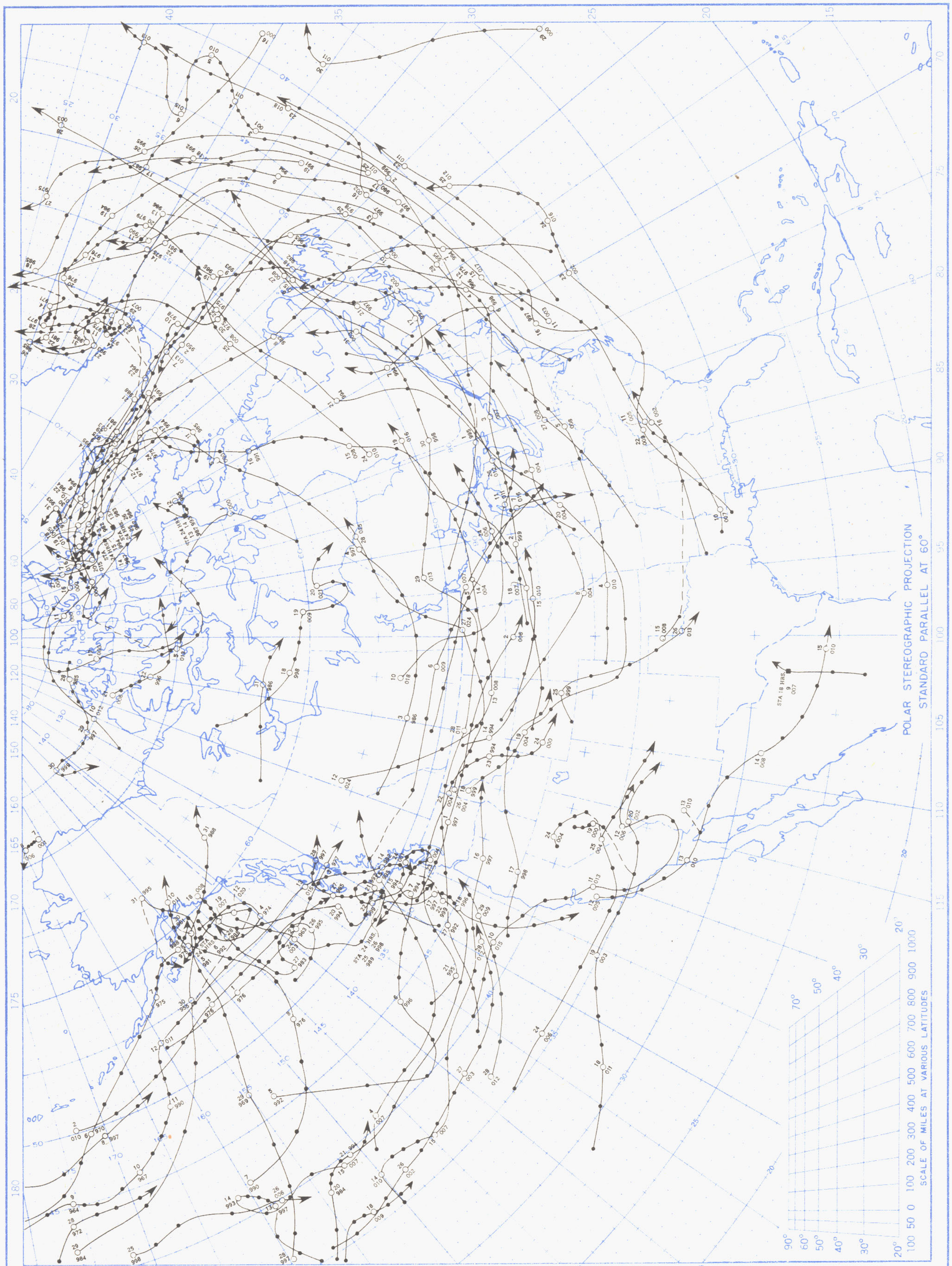
Chart shows mean daily solar radiation, direct + diffuse, received on a horizontal surface in langleys (1 langley = 1 gm. cal. cm.$^{-2}$). Basic data for isolines are shown on chart. Further estimates are obtained from supplementary data for which limits of accuracy are wider than for those data shown. Normals are computed for stations having at least 9 years of record.

Chart IX. Tracks of Centers of Anticyclones at Sea Level, January 1954.



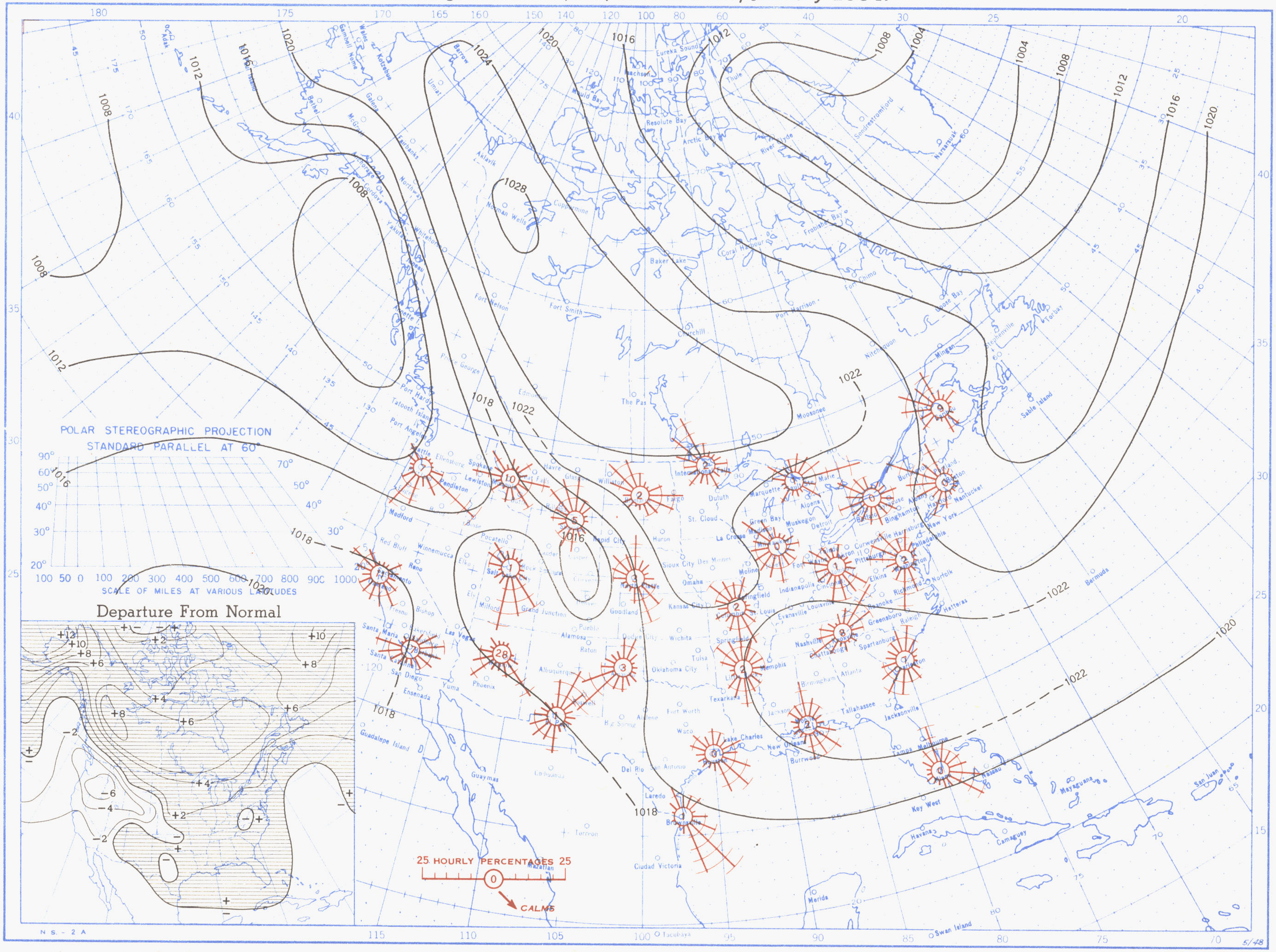
Circle indicates position of center at 7:30 a.m. E. S. T. Figure above circle indicates date, figure below, pressure to nearest millibar. Dots indicate intervening 6-hourly positions. Squares indicate position of stationary center for period shown. Dashed line in track indicates reformation at new position. Only those centers which could be identified for 24 hours or more are included.

Chart X. Tracks of Centers of Cyclones at Sea Level, January 1954.



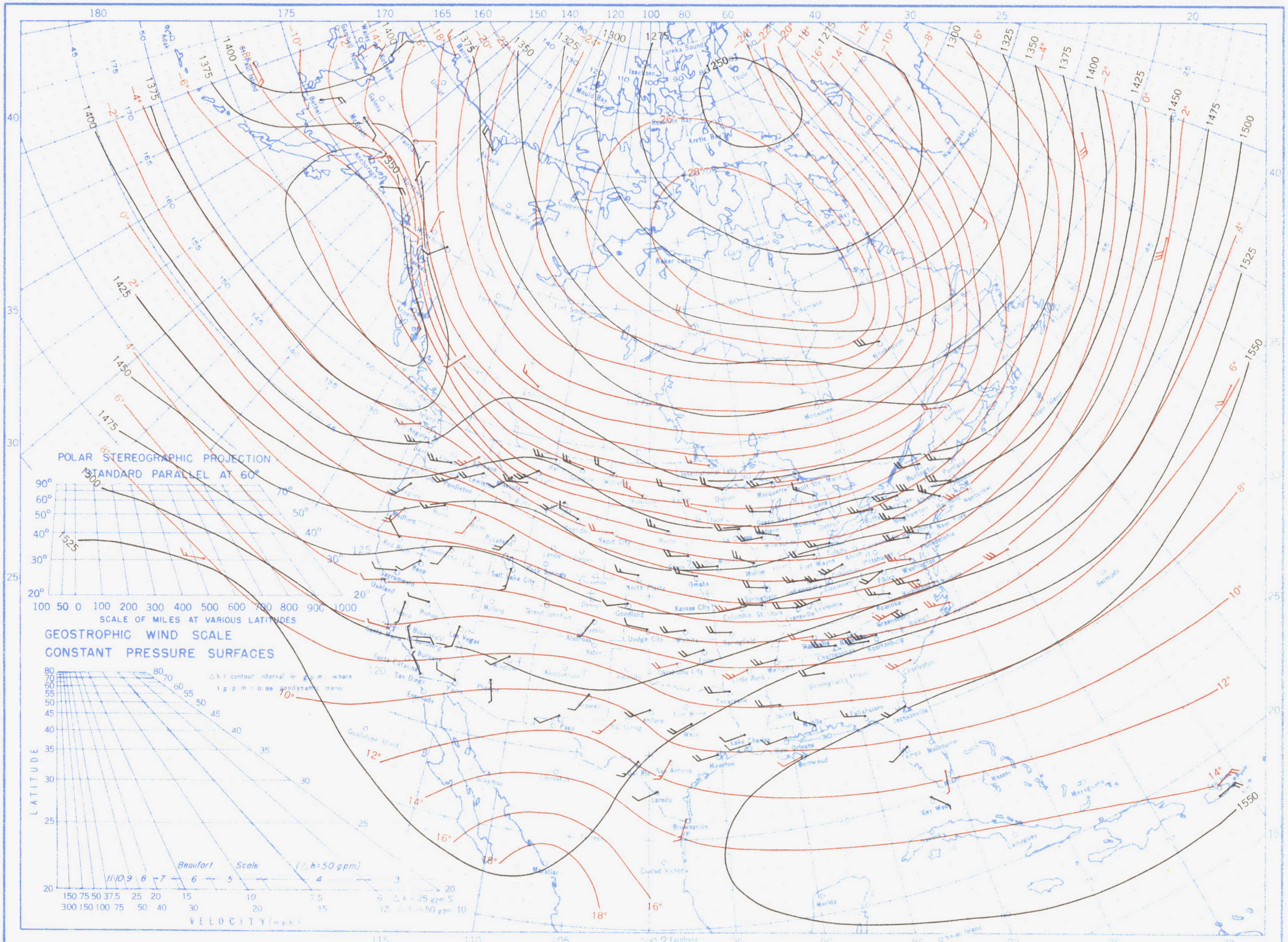
Circle indicates position of center at 7:30 a. m. E. S. T. See Chart IX for explanation of symbols.

Chart XI. Average Sea Level Pressure (mb.) and Surface Windroses, January 1954. Inset: Departure of Average Pressure (mb.) from Normal, January 1954.



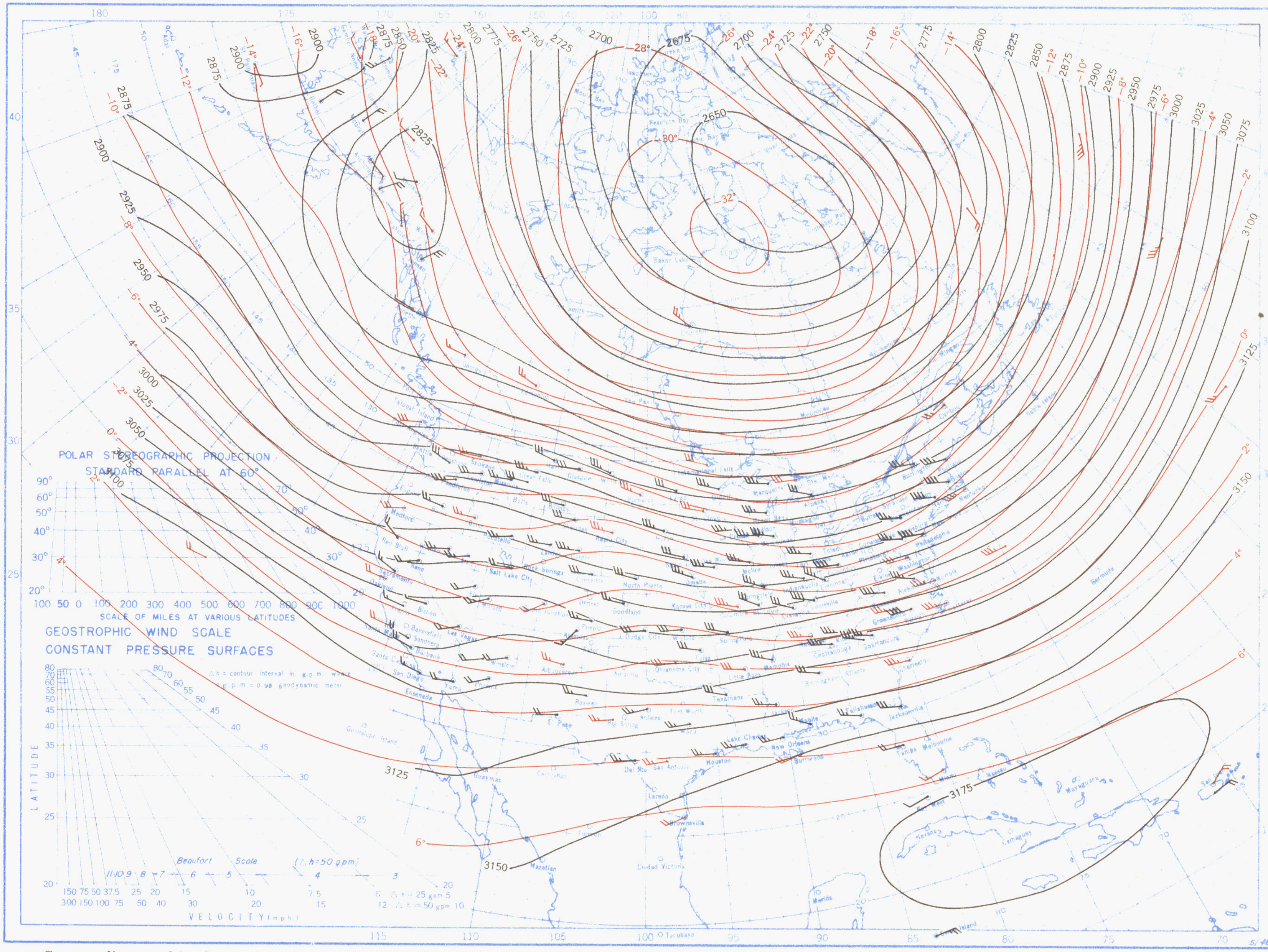
Average sea level pressures are obtained from the averages of the 7:30 a.m. and 7:30 p.m. E. S. T. readings. Windroses show percentage of time wind blew from 16 compass points or was calm during the month. Pressure normals are computed for stations having at least 10 years of record and for 10° intersections in a diamond grid based on readings from the Historical Weather Maps (1899-1939) for the 20 years of most complete data coverage prior to 1940.

Chart XII. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 850-mb. Pressure Surface, Average Temperature in °C. at 850 mb., and Resultant Winds at 1500 Meters (m.s.l.), January 1954.



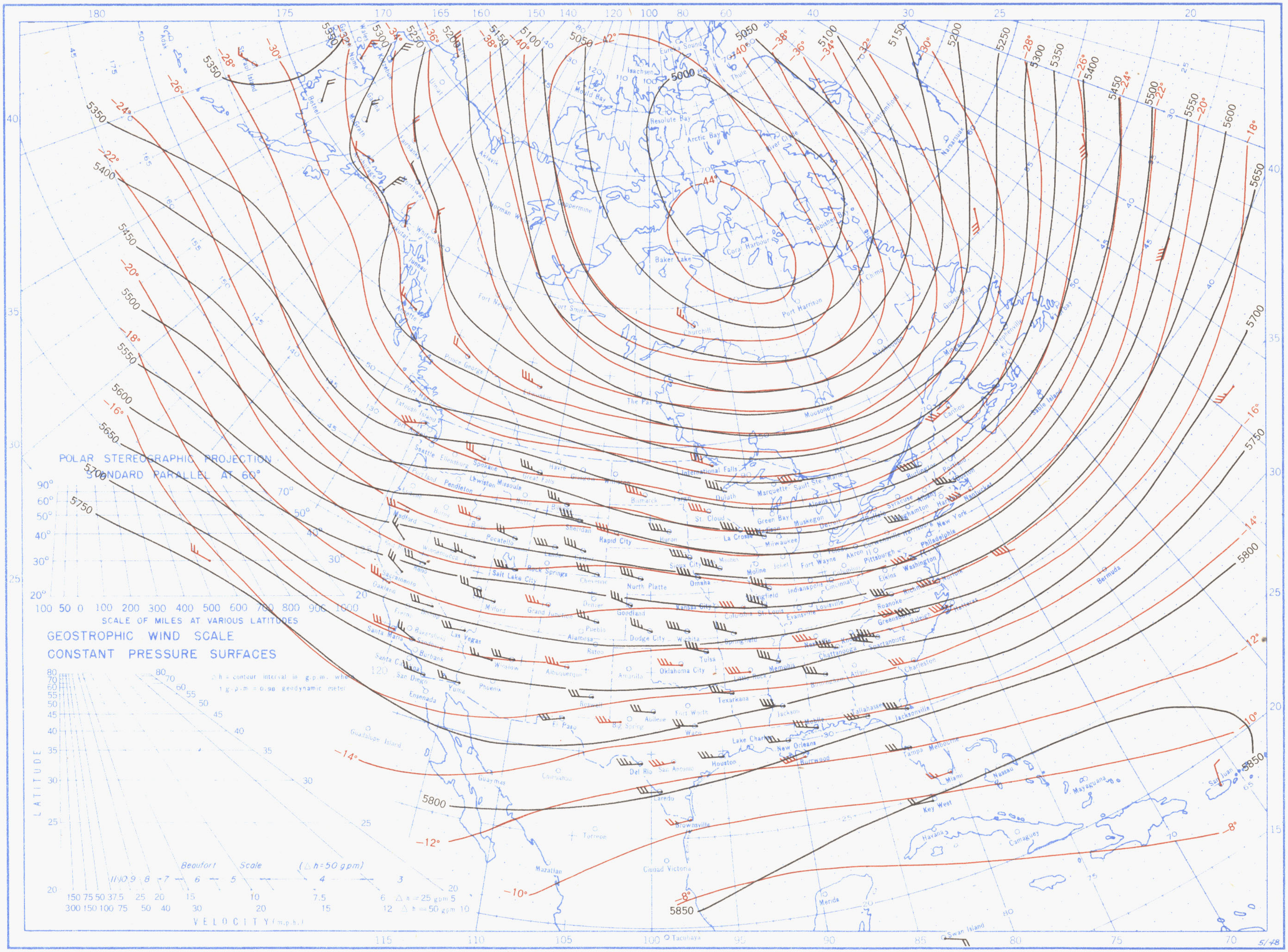
Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins taken at 0300 G. M. T. Wind barbs indicate wind speed on the Beaufort scale.

Chart XIII. Average Dynamic Height in Geopotential Meters (1 g.p.m.. = 0.98 dynamic meters) of the 700-mb. Pressure Surface, Average Temperature in °C. at 700 mb., and Resultant Winds at 3000 Meters (m.s.l.), January 1954.



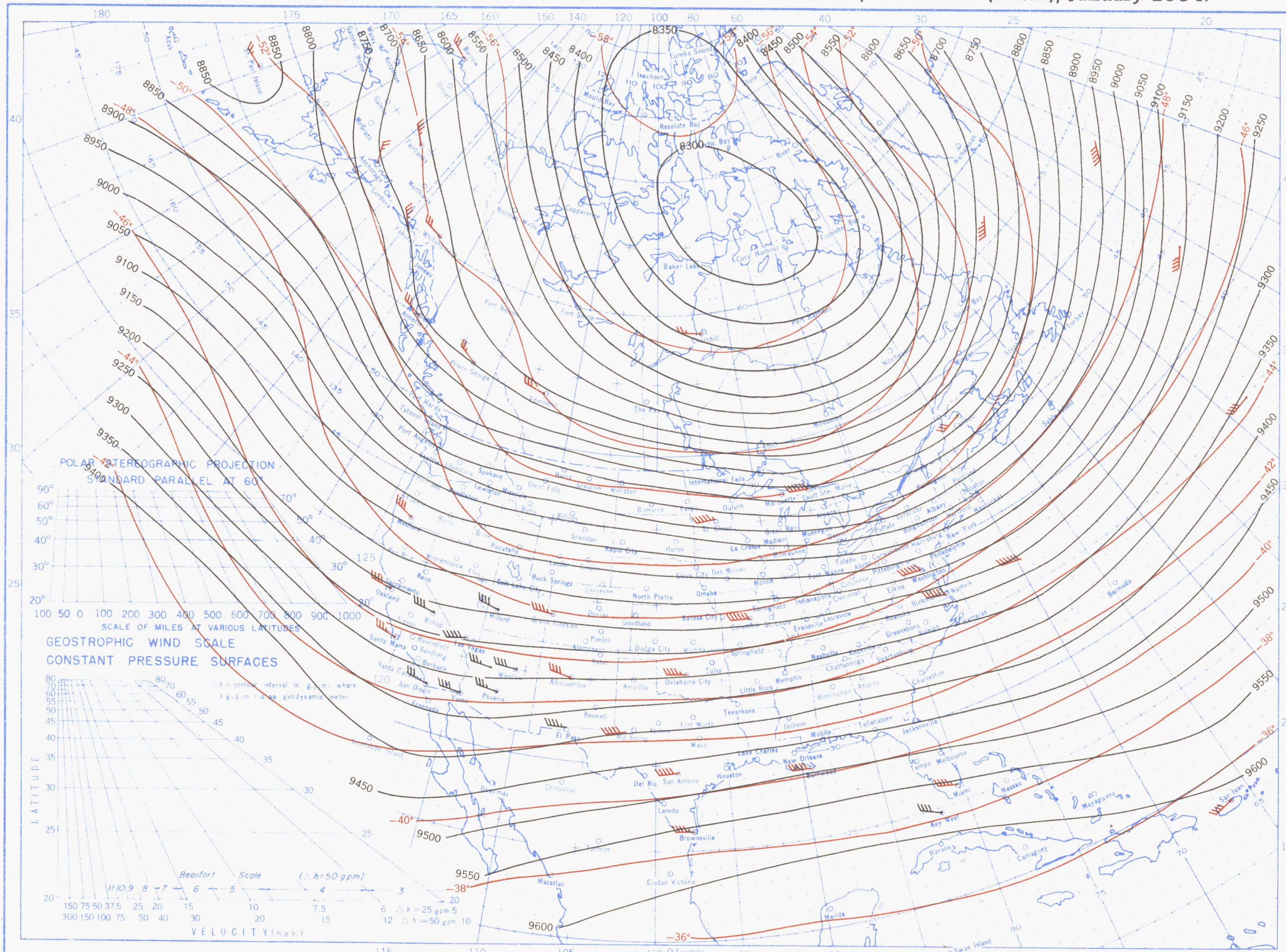
Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins taken at 0300 G. M. T. Wind barbs indicate wind speed on the Beaufort scale.

Chart XIV. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 500-mb. Pressure Surface, Average Temperature in °C. at 500 mb., and Resultant Winds at 5000 Meters (m.s.l.), January 1954.



Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins at 0300 G. M. T. Wind barbs indicate wind speed on the Beaufort scale.

Chart XV. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 300-mb. Pressure Surface, Average Temperature in °C. at 300 mb., and Resultant Winds at 10,000 Meters (m.s.l.), January 1954.



Contour lines and isotherms based on radiosonde observations at 0300 G. M. T.; those shown in red are based on rawins at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; Wind barbs indicate wind speed on the Beaufort scale.